Chapter 7

Concluding Remarks

7.1 Major Conclusions

The major results of this work are:

- The broad He I emission feature from IRS 16 arises from stellar winds associated with the bright stars.
- The bright blue sources at the GC are apparently evolved stars from a recent star formation episode.
- The bright blue sources' contributions to the region's ionization are poorly constrained, but the ionization is naturally explained by the large population of hotter, late-OV stars expected to accompany the evolved stars.
- Considered individually, the helium emission stars are not peculiar, although they are remarkable with very high luminosities for warm stars.
- As a group and in the context of the region's red population, the He I star population is inconsistent with the predictions of a single episode starburst model, even with generous allowances for the uncertainties in massive stellar

evolution. A starburst extended slightly in time provides more parameters but is a better fit.

- The nuclei of M31 and M32 do not have similar populations. This indicates that the GC is in some way unique or in a transitory state, ruling out many steady-state models for the blue sources.

- Expected influences on single star evolution cannot explain this peculiar population; interactions among the massive stars, or with the mass-dominating population, or with Sgr A* are not probable explanations.

- Unusual conditions of formation are speculated to lead to a higher fraction of luminous helium stars. The tight-binary fraction may be enhanced or there may be a strong predilection to very massive stars.

- We confirm that stellar interactions may cause the observed gas clouds and CO depletion region. We find that tidal capture into close binaries is the most likely mechanism.

- Kinematics derived from the He I population are consistent with those derived from CO-bandhead and gas kinematics. An upper limit on the central mass of 1.8×10^6 M$_\odot$ is derived from these data alone, substantially lower than found by Krabbe *et al.* (1995).

Our proximity has allowed us to probe details of the GC which are unnoticed in more distant nuclei. With these details have come more perplexing problems. Having determined that the GC is in a transient state, how often does this state recur and what fraction of other nuclei share similar populations?

7.2 Future Directions

New observations will continue to add to our understanding of this region and the dominant processes in galactic nuclei, and to the questions we must address. We have seen that high spectral resolution is an important tool in K-band observations of the warm, luminous stars. Larger comparison samples with broader wavelength coverage and studies of the surrounding star formation areas with comparable resolution may be able to clarify the peculiarity of the individual stars. Adaptive optics and space based observations will make the crowding less of a problem. This will permit higher precision color determinations, deeper luminosity functions extending to the main sequence, searches for eclipsing and intrinsically variable stars, and less contaminated spectroscopy. Proper motion and high-resolution radial velocity measurements will allow characterization of the stellar orbits and mapping of the central mass distribution. Space-based observations of other galactic nuclei can extend the sample of nuclei in which we can test for the presence of similar populations beyond M31 and M32. Adding realistic star formation histories and stellar orbits to red-giant tidal-capture models will allow us to address whether the CO depletion region has an extent consistent with what this mechanism would produce.

We have shown that the bright He I sources in the GC are similar to extreme stars seen elsewhere but unique as a population. This population must arise from peculiar formation rather than from unusual stellar evolution unique to this region. The peculiarity of the warm population raises the issue of how star formation in dense galactic nuclei is different from formation in less dense regions.

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